FODDER QUALITY IN SORGHUM*

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FORAGE quality is an important selection criterion in fodders especially so in fodder sorghum because they are tropical in distribution where the quantity of feed is often not the limiting factor in animal performance. Protein content and digestibility of fodder are two important components of quality in fodder sorghum. Plant breeding efforts are in vogue since a long time to improve protein content in fodders. However, it is only of late that it has become possible to select plants for digestibility (Tilley and Terry, 1963; Sleeper *et al.*, 1973). In this study, an effort is made to understand the genetics of these two component characters of forage quality and to evolve an optimum breeding philosophy to improve quality of fodder sorghum.

MATERIALS AND METHODS

The material for the present study comprised of seven *elite* fodder sorghum lines (Pusa Chari-1, Pusa Chari-2, IS 941, SL44, SSG 59–3, JS 20 and A1-14–8) and three *elite* grain sorghum lines (CSV-1, CSV-4 and DJ 713). The 55 progenies (45 F_1s + 10 parents) produced by mating them in a diallel fashion were grown in a randomised block design with three replications. The same ten lines were also crossed to four male sterile lines, 'CK 60A' '2219A', '1036A' and '10590A'. The resulting 40 crosses and the 14 parents were laid out in a randomised block design with three replications. In this experiment, parents and crosses were planted in separate blocks.

The crude protein content was estimated using a protein autoanalyser and expressed as percentage of dry matter. Dry matter digestibility was obtained according to the method given by Sleeper *et al.* (1973). This technique is an improvement over the technique for *in vitro* digestion of forage crops given by Tilley and Terry (1963). The acid-pepsin solution in this procedure was prepared by dissolving 2 g pepsin(strength-1000E/g, DAB 5, from RIEDEL, Germany), and 100ml1NHcl in enough distilled water to make up one litre. The diallel data was analysed for combining ability estimates according to the procedures of Griffing (1956) method 2, model I. The line × tester data was analysed according to the procedure of Kempthorne (1957) and Arunachalam (1974).

RESULTS

Analysis of variance for combining ability (Table 1) indicated that GCA and SCA variances were significant for both the quality characters in the two experiments indicating the operation of both additive and non-additive effects in determining these characters. Ratio of GCA to SCA variances in the diallel experiment and the non-significant line × tester interaction source in the line × tester experiment indicated that additive genetic variance was preponderant for protein and Content digestibility.

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TABLE 1

Analysis of variance for combining ability

Source of variation	DF	Protein content	IVDMD
	Diallel		
GCA	9	2.09**	48.47**
SCA	45	1.66**	7.15**
Error	108	0.27	3.26
GCA/SCA Ratio	—	1.25	6.92
	Line × Tester		
Lines	3	5.38**	60.62**
Testers	9	5.64**	36.24**
Lines × testers	27	1.87**	12.05
Error	78	0.77	12.25
	Variance Estimates		
	DF(1) DF(2)		
Lines	3 27	0.12	0.62**
Testers	9 27	0.31*	2.02*
GCA	+ 27	0.17*	1.73**
		(9)	(6)
SCA	27 78	0.37**	(-ve)

+Figures in the paranthesis are the DF(1) of GCA variance estimates.

Estimates of GCA effects (Table 2) indicated that for protein content, 'DJ 713', 'CSV-1', 'IS 941' and 'A1-14-8' had positive GCA effects. However, only 'CSV-1' and 'A1-14-8' showed consistent GCA effects over the two experiments for protein content. The *bicolor* type varieties, 'Pusa Chari-1', 'DJ 713', 'CSV-1' and 'CSV-4' showed positive GCA effects for IVDMD in both the experiments. Only the GCA effects of 'Pusa Chari-1' and 'CSV-4' were positive and significant in both the experiments. These parents being grain sorghum types, it was clear that grain sorghums definitely influenced the IVDMD positively and could become useful breeding material. All the other parents, i.e., the sudanense types exhibited negative GCA effects. Among the male steriles studied, only '2219A' and '1036A' registered positive and significant GCA effects for protein content and IVDMD, respectively.

Only three crosses exhibited significantly high positive SCA effects for protein content. They were 'SL 44 × SSG 59-3' 'SSG 59-3 × JS 20' and 'DJ 713 × CSV-4'. The crosses which showed significant SCA effects for IVDMD were 'JS 20 × DJ 713', 'Pusa Chari-2 × IS 941', 'SSG 59-3 × CSV-4' and 'Pusa Chari-2 × SL 44'. Among the crosses with male steriles, '10590A × DJ 713'

TABLE 2

Estimates of the GCA effects of the parents

Parent	Protein content		IVDMD	
	DL	LT	DL	LT
Pusa Chari-1	-0.63**	-0.15	1.53**	2.26**
Pusa Chari-2	-0.45**	-0.59**	-1.71**	-1.59
IS 941	0.36**	-0.64**	-1.15**	-0.46
SL 44	0.28*	-0.17	-2.04**	0.29
SSG 59-3	0.02	-0.12	-0.86	-0.46
JS 20	0.14	-0.69**	-0.73	-2.98**
A1-14-8	0.52**	0.26	-1.91**	-1.10
DJ 713	-0.61**	0.86**	4.06**	0.08
CSV-1	0.11	1.43**	1.19**	1.27
CSV-4	0.23	-0.17	1.61**	2.68**
Var (g_i)	0.02	0.06	0.24	0.92
Var (g_i-g_j)	0.04	0.13	0.54	2.04
CK 60A	—	0.27**	—	-1.28**
2219A	—	0.35**	—	0.95
1036A	—	-0.58**	—	1.47**
10590A	—	-0.04	—	-1.14*
Var (g_i)	—	0.02	—	0.31
Var (g_i-g_j)	—	0.05	—	0.82

was found to be the best combiner for protein content and '1036A × DJ 713' was the best specific combiner for IVDMD.

DISCUSSION

Forage quality is best defined as output per animal and is a function of voluntary intake and digestibility of nutrients when forage is fed alone and *ad libitum* to a specified animal (Moore and Mott, 1973). Though forage quality involves many physical and chemical selection parameters, for practical breeding purposes, it is recognised that selection based on protein and *in vitro* dry matter digestibility, depending on their mode of inheritance, would give substantial progress in improving quality.

It was brought out in the present study that 'Pusa Chari-1' could be used as a genetic source for improving digestibility of fodders. However, it has the snags of leaf spot susceptibility and being early, is a low fodder yielder compared to some of the recently released varieties like 'Pusa Chari-6'.

The grain sourghums were found to be better general combiners compared to fodder sorghums for both the quality traits. The superiority of grain compared to fodder types was also clearly brought out in an earlier study (Vasudeva Rao and Ahluwalia, 1980). In the present study, it was observed that protein content and digestibility were controlled by both additive and non-additive genetic systems with a preponderance of additive gene action. These two characters were negatively correlated (−0·29*) warranting a careful handling during the breeding process. Hence for a long term improvement in protein and digestibility, it was suggested that reciprocal recurrent selection would be useful. However, since the additive gene action is highly in excess of the non-additive gene action, it could be capitalised upon by resorting to straight selection in the segregating populations for improving protein content and digestibility.

Summary

The genetics of protein content and IVDMD of fodder sorghums was studied in a 10-parent diallel and a 4 × 10 line × tester mating designs. Both the characters exhibited preponderant additive gene action in their inheritance in addition to presence of non-additive genetic variance. The grain sorghums were better general combiners than fodder sorghums for the quality characters. 'Pusa Chari-1' was found to be a good genetic source for improving digestibility. Reciprocal recurrent selection after an initial straight selection for the quality characters is suggested as the breeding procedure to be adopted to improve fodder quality in sorghums.

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